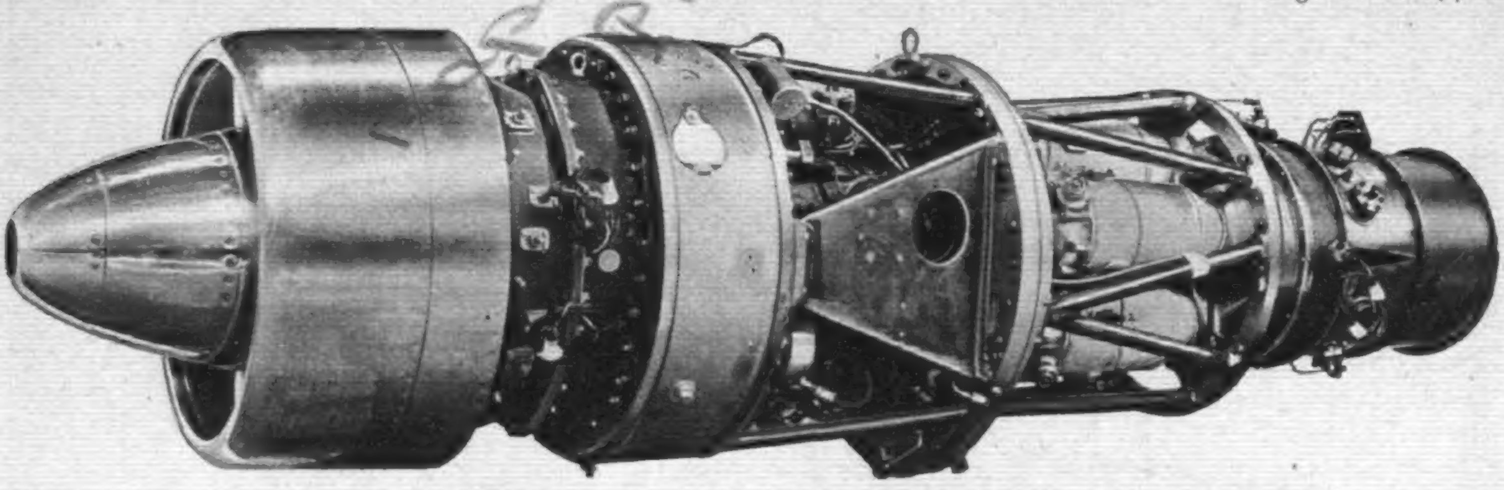

# Napier Naiad

## Novel Design Features Embodied in the Most Recent of British Airscrew-Turbines

ONE hundred and forty years ago a young Scotsman named David Napier set out by sailing ship from Edinburgh's port of Leith and voyaged down to London with an idea and resolution. He thought that the wooden-framed printing machines of his day could be better built with metal frames, and he founded a company with premises in Soho to prove it. In that year of 1808 David Napier was 22 years old; he died at the age of 85, having established his name enduringly in the engineering world, and we feel it is a pleasing speculation to wonder what the old gentleman would have to say about the latest product to bear that name, the Naiad airscrew-turbine.

Of the three British units of its class, the Naiad at 1,500 h.p. is the most powerful—the Rolls-Royce Dart gives 1,125 h.p. and the Armstrong-Siddeley Mamba 1,010 h.p.—and yet the overall dimensions of the Naiad are not proportionally greater. This has been made possible only by the unique structural form employed, which, in turn, has coloured the dynamic design of the engine.

From the main mounting points on the firewall at the rear of the engine, a framework of tubular bracing struts extends forward to the central mounting ring lying in the plane of the final compressor stage. By utilizing the largest possible diameter (28in) for the concentration of engine mounting loads, the point load at any one section is a minimum. From this main mounting ring, subsidiary supporting structures project forward to carry the front half of the engine, picking up for this purpose on the reduction gear casing, and also run rearward to support the rear half of the engine by attaching to the turbine inlet manifold.

This system of engine mounting renders it unnecessary for the compressor casing and the turbine shaft housing to carry bending loads, and so contributes largely to the reduction in weight of these parts of the engine. However, the adoption of this method of mounting has necessitated the introduction of articulation as between the three main elements of the rotating system. It is for this reason that the compressor is carried in a gimbal assembly at its rear end, and in a self-aligning bearing at its forward end, the torque connection being made with annular couplings.

In order to attain the clearest picture of the Naiad build-up, the best way is, we consider, to progress systematically through the unit from airscrew spinner to tailcone. But before starting this survey it is felt worthwhile, for the benefit of readers who may not be overly familiar with the gas turbine principle, to dilate slightly upon the differences between turbine units designed to drive airscrews and those designed for jet propulsion.

With a jet engine, the aim is to provide the greatest mass flow possible within the physical limits imposed by size and weight parameters, and the turbine is designed to extract from the jet only just sufficient energy to power the compressor, which, of course, is the primary source of the mass flow. In airscrew turbines, or turboprops as they are now more commonly known, propulsion is vested in an airscrew and, as the sole source of the power in the engine is the turbine, it is patent that the turbine must be of such design that it extracts the maximum energy from the jet in order, first, to serve the compressor and then to feed into the airscrew what remaining power is left over. Thus the generalization can be stated that, in a jet engine, the turbine is designed to extract the minimum of energy from the gas flow, whilst in a turboprop the turbine is designed to extract the maximum of energy from the gas flow. For these reasons, single-stage turbines are more usually employed in turbojet units, whilst multi-stage turbines are more often found in turboprop designs.

### Detail Analysis

Now to start on our appraisal of the Naiad: the air is taken into the unit through the medium of a hollow spinner, a development in which Napiers have played a leading part for some considerable time (see *Flight*, October 3rd, 1946, and May 20th, 1948), and is fed to the compressor via two kidney-section ducts passing on each side of the reduction gear and integrally formed in the reduction gear casings. There are three of these casings which go to make up the reduction gear box, the internal diaphragms accommodating the various shaft bearings, whilst the outer wall of the rearmost part of the casing is fashioned with twin cavities utilized as oil tanks, the forward volume serving the governor unit, whilst the rearward cavity is, in fact, the engine sump.

The reduction gear is itself noteworthy in being of spur-type and yet providing the comparatively large step-down ratio of 14 : 1, this being achieved with a single intermediate stage. A central input pinion coupled to the compressor shaft meshes with a pair of large-diameter wheels, hub-splined to torsion quill-shafts which transmit the drive to layshaft pinions, each of which mesh with the main central wheel bolted direct to the airscrew shaft. In form, this reduction gear justifies the use of the term layshaft system, although, in actual fact, layshafts as such are not employed. The torsion quill-shafts, which perform the